ELECTRIC VEHICLE AND POWER PLANT EMISSIONS UPDATE

SOUTH COAST AIR BASIN

Staff Paper
by

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I. INTRODUCTION

The California Air Resources Board (CARB) is scheduled to consider adding an optional equivalent zero-emission vehicle (EZEV) standard to its low-emission vehicle (LEV) regulations. The proposed EZEV standards were developed based on the level of South Coast Air Basin (SCAB) power plant emissions of oxides of nitrogen (NOx) and reactive organic gases (ROG) associated with charging battery-powered electric vehicles. Certification of EZEVs require meeting standards for four criteria pollutants: NOx , ROG, carbon monoxide (CO), and particulate matter less than 10 microns (PM10). Certified EZEVs would receive credit toward a manufacturer's 2003 ZEV requirement.

LEV regulations establish emission standards for four categories of vehicles: transitional low-emission vehicles (TLEVs), low-emission vehicles (LEVs), ultra low-emission vehicles (ULEVs) and zero-emission vehicles (ZEVs). The regulations apply to light-duty trucks and passenger cars weighing less than 3,750 pounds. Battery-powered vehicles are the only ones currently available to certify to the ZEV standard. The EZEV standard would be added to the LEV regulations and establish a fifth category. In order for a vehicle to qualify for certification to the EZEV standards, fuel-cycle emissions upstream from refueling must meet the EZEV standards. If the fuel passes this test, then the vehicle must meet the standard for all four pollutants before it can certify and get credit for being an EZEV.

CARB staff believes it is important that manufacturers and developers of alternative/advanced transportation technologies be provided an opportunity to receive appropriate credit for extremely low-emission vehicles if they demonstrated emission reductions equivalent to a ZEV. As part of the CARB staff's development of the EZEV standard, California Energy Commission staff was asked to analyze the emissions associated with the incremental power needed to satisfy electric vehicle (EV) demand in the South Coast Air Basin. Energy Commission staff originally provided this analysis to CARB for their Low-Emission and Zero- Emission Vehicle Forum in August 1995. This study updates that analysis with new assumptions incorporating CARB proposed modifications to the ZEV implementation schedule and new data developed in the Energy Commission's ***1996 Electricity Report*** (ER96) and ***1995 Fuels Report*** (FR95) proceedings.

This study analyzes only incremental power plant emissions and not the emissions avoided by gasoline or other fuel-powered vehicles. It does not represent, either directly or indirectly, Energy Commission policy or perspective on the proposed CARB regulation, the feasibility of alternative vehicles to meet the proposed standard, or the viability of alternative vehicles (including EVs) in the marketplace. Finally, this study does not address the overall issue of air quality in the South Coast Air Basin.

II. METHODOLOGY

The methodology used in this study is essentially unchanged from the June 1995 Energy Commission staff report.[1] The analysis entails a two-step approach 1) building an electric utility resource plan using the Electric Utility Financial and Production Cost (Elfin) Model that provides adequate resources to meet demand and reliability requirements, and 2) completing Elfin model production simulation runs to compare power plant emissions with and without EVs. CARB and Energy Commission staff decided on a number of different assumptions to characterize the additional demand for electricity due to EVs. Energy Commission staff then used Elfin to determine the amount of additional electric generation to meet EV load and to determine which power plants would generate this marginal electricity and associated emissions.

Staff analyzed data for the years 2005 and 2010. Results, however, are provided only for 2010 because in 2005 the number of EVs (and therefore the load characterized in Elfin) is fairly low and could produce anomalous results.

III. ASSUMPTIONS

During the original study, CARB and Energy Commission staff developed a series of plausible assumptions regarding the number of EVs and their distribution, the average number of annual miles traveled by these vehicles, and expected EV efficiency in kilowatt-hours per mile. Although assumptions regarding annual vehicle miles traveled, EV recharging patterns, and EV efficiency scenarios remain unchanged from the original study, other assumptions have been modified.[2] Each change is identified below with a brief description of the actual data changed.

Staff originally used ER94 Elfin data sets for Edison and Los Angeles Department of Water and Power (LADWP), modified with EV loads, load shapes, and updated assumptions provided by utilities and staff regarding power plant characterizations. Staff has now further modified the data sets, called "draft Electricity Resource Assessment Office (ERAO) 96" data sets, to incorporate new information obtained in the ER96 process, California Public Utilities Commission (CPUC) electricity restructuring and other proceedings at the CPUC, and a series of discussions with CARB staff and various air districts staff. This combined information was characterized in Elfin to then generate data on incremental emission changes.

Distribution Scenarios

[1] Electric Vehicle and Power Plant Emissions, P. McAuliffe, A. Tanghetti, June 28, 1995, California Energy Commission Staff Report.

[2] Recharging patterns remain unchanged in this analysis. The "off-peak" shape continues to place 95 percent of the recharging load into off-peak periods with 5 percent of the load into the on-peak period. The "on-peak" shape places 16 percent of the recharging load into the on-peak period, with 84 percent occurring during off-peak periods. Peak hours for Edison load are from 12 noon to 6 p.m. LADWP's peak load hours are from 11 a.m. and 7 p.m. Vehicle miles driven by EVs remain at 10,000 miles per year. EV fleet average efficiencies remain at 0.24 kWh per mile and 0.35 kWh per mile, respectively. However, depending on future technological developments, the efficiencies of some EVs may be outside the bounds of efficiencies used in this analysis.

Different from the previous study, which evaluated three different EV distribution scenarios, staff considered one distribution scenario in this study assuming 55 percent of all EVs in California are distributed in the South Coast Air Basin. Of the 55 percent, it was assumed that 70 percent of the vehicles will be located in the Edison area and 27 percent in the LADWP area. The remaining three percent are assumed to be recharged by other utilities such as the cities of Burbank, Glendale, and Pasadena.

The scenario described above is equivalent to the "Medium" case scenario used in the June 1995 report. CARB staff requested that Energy Commission staff eliminate the 80 percent (High Case) and 40 percent (Low Case) from this analysis because these cases are believed to be less plausible and the results were not significantly different from the "Medium" case.

Number of EVs

The number of EVs in California is assumed to equal the number required by CARB's ZEV requirements. Originally, two percent of new car sales in California would be required to be ZEVs by 1998, escalating upward to 10 percent per year by the year 2003. In March 1996, CARB modified the implementation date of its ZEV requirement from 1998 to 2003 retaining the 10 percent EV market penetration threshold for the 2003 year. As the rightmost two columns of Table 1 indicate, the change in the ZEV requirement reduces the statewide projection of EVs on the road by approximately 370,000 by the year 2010 (subtracting the total number of vehicles in the June 1995 analysis from the current analysis). In the South Coast Air Basin, the reduction amounts to approximately 200,000 vehicles by 2010.

TABLE 1
PROJECTED NUMBER OF ELECTRIC VEHICLES: 1998-2010 (Thousands)

	South Coast Air Basin				Total California	
	Southern California Edison	Los Angeles Dept. of Water & Power	Rest of South Coast Air Basin	Total South Coast Air Basin	Current Analysis	June 1995 Analysis
1998	0	0	0	0	0	27.0
1999	0	0	0	0	0	54.0
2000	0	0	0	0	0	82.0
2001	0	0	0	0	0	153.0
2002	0	0	0	0	0	224.0
2003	43.6	16.8	1.9	62.3	113.2	369.0
2004	94.2	36.3	4.1	134.6	244.7	517.0
2005	145.7	56.2	6.2	208.1	378.3	667.0
2006	198.0	76.4	8.5	282.9	514.3	819.0
2007	251.3	96.9	10.8	359.0	652.7	974.0
2008	305.4	117.8	13.1	436.3	793.3	1131.0
2009	360.5	139.0	15.6	515.1	936.6	1291.0
2010	416.3	160.6	17.9	594.8	1081.4	1453.0

Source: California Air Resources Board, May 1996 Fax Transmittal to Energy Commission Staff (based on CARB mobile source emission inventory).
Note: It is assumed that 55 percent of all EV sales in California are distributed in South Coast Air Basin. Within the basin, 70 percent are located in the Edison service territory and 27 percent in the LADWP service territory. The remaining three percent comprises miscellaneous utilities in Southern California.

Electricity Demand Forecast

With the exception of EV demand, the electricity demand forecast for all sectors has been updated to reflect preliminary estimates adopted by the Energy Commission in its ***1996 Electricity Report*** proceeding. Staff revised the peak and sales characterizations in the Elfin data sets by removing the EV loads forecasted in the ER96 adopted demand forecasts. Staff then calculated new EV loads based on the following formula:

EV Efficiency Rating (kWh/mile) * Vehicle Miles Traveled (miles/yr) * Number of EVs (%) * Line Losses (%) * Vehicle Penetration (55%) * Percent Attributed to Edison and LADWP

Table 2 presents the forecast of EV load (demand) assumed for the Edison and LADWP service areas. Assuming a 0.24 kWh per mile efficiency rating, the amount of electricity needed to serve the Edison EV markets ranges from 112 GWh in 2003 to 1067 GWh by 2010. Electricity requirements for EVs in the LADWP EV market ranges from 45.8 GWh in 2003, increasing to 437.4 by 2010. Using a 0.35 kWh per mile efficiency factor increases the projected requirements by 46 percent in both service areas.

TABLE 2
ELECTRIC VEHICLE ELECTRICITY DEMAND
IN EDISON AND LADWP SERVICE AREAS
(Gigawatt Hours)

	0.24 kWh per Mile EV Efficiency		0.35 kWh per Mile EV Efficiency	
	Southern California Edison	Los Angeles Dept. of Water & Power	Southern California Edison	Los Angeles Dept. of Water & Power
2003	111.7	45.8	162.9	66.8
2004	241.5	99.0	352.1	144.3
2005	373.4	153.0	544.5	223.2
2006	507.6	208.1	740.2	303.4
2007	644.1	264.0	939.3	385.0
2008	782.9	320.9	1141.7	468.0
2009	923.9	376.7	1347.4	552.3
2010	1067.1	437.4	1556.2	637.9

Source: California Air Resources Board

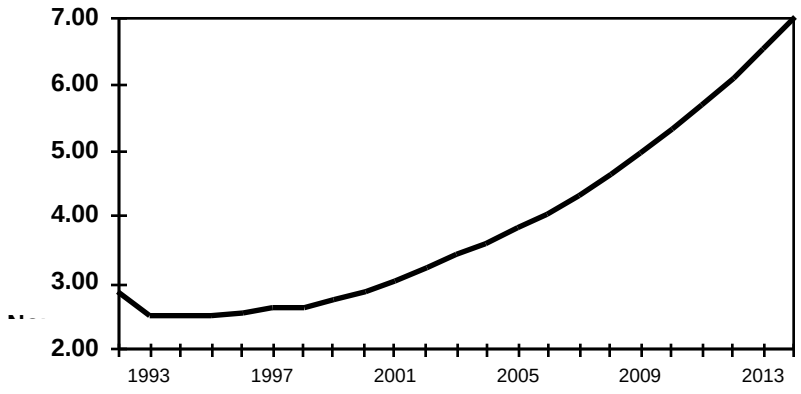
Note: Line losses of 6.8 percent and 13.5 percent assumed for Edison and LADWP systems, respectively.

Natural Gas Price Forecast for Electric Generation

Since the completion of the June 1995 analysis, the Energy Commission adopted a natural gas price and supply forecast as part of the ***1995 Fuels Report***. This update incorporates the adopted figures and converts them into nominal dollars using a deflator series adopted for use in the ***1996 Electricity Report*** proceeding.

Forecasted natural gas prices for electric generation are illustrated in Figure 1. Prices through the rest of this decade remain relatively flat, escalating substantially after the year 2000. The annual nominal escalation rate assumed from 1995 to 2015 is 5.6 percent, including inflation. In real terms, the annual rate of growth is closer to two percent.

Figure 1
Natural Gas Price Forecast for Electric Generation
Southern California Gas Company Service Area



Source: California Energy Commission, Staff's ER96/FR95 Natural Gas Price Forecast for Electric Generation, September 1995.

Losses

The ER 96 adopted demand forecast included updated transmission line loss factors. The updated load line loss factor for Edison is 6.8 percent. LADWP's line loss factor remains the same as ER94 at 13.5 percent.

Reserve Margin

Reserve margins were changed from 16 and 20 percent (Edison and LADWP) to 10 percent for each. The changes were made to incorporate staff's perception that in a restructured utility environment, resources are pooled. Edison's responsibility for reliability will be subsumed by the Independent System Operator (ISO). LADWP, unless it joins the Power Exchange (PX)/ISO, will have to meet its own reliability requirements. Staff assumed for modeling purposes that LADWP will join the PX/ISO.

Northwest and Southwest Non-firm Energy Prices (NWNF, SWNF)

Out-of-state hydroelectric, natural gas and coal prices contain a component that is tied to the price of natural gas. The ER94 NWNF energy prices were updated to reflect the new adopted natural gas dispatch fuel price forecast in FR95. The methodology used to update the NWNF prices remains the same as that used in ER94.[3]

[3] 1994 ELECTRICITY REPORT, Electricity Supply Assumptions Report (ESPAR), Part III, The Availability, Price and Emissions of Power from the Southwest and Pacific Northwest .

SWNF was previously calculated using the Surplus Energy Resource Assessment Model (SERAM) model. SERAM estimated the economy energy available from the Pacific Northwest and Southwest regions applying transmission system constraints, and estimated how much economy energy is available and transferable to California utilities. However, staff was unable to forecast SWNF using SERAM for the EV analysis. Instead, staff adjusted the ER94 SWNF prices using the average difference between ER94 and ER 96 NWNF prices.

Unserved Energy (Energy Not Served) and Spinning Reserve

In ER94, the cost of unserved energy and emergency spin for all utilities was based on the cost of fueling a combustion turbine and a heat rate. Each utility had a different cost: PG&E used a distillate fuel price, while Edison used a mix of diesel and natural gas prices and SDG&E only used a natural gas price.

Staff realized that in a restructured environment the cost for avoiding spin or unserved energy would be similar for each utility since each utility would be purchasing spot energy via the Power Exchange and ancillary (spinning reserve etc.) services through the ISO. Staff also assumed the price would be high (in Elfin, unserved energy is the last "unit" and spinning reserve one of the last units dispatched and is for unserved energy an indication that you are out of generation options or resources). Staff set the price in 1996 at $0.05 per kWh, escalating at 3.5 percent per year.

System Commitment and Spin Targets

In the past, commitment target was a percentage reflecting the single largest contingency necessary to meet system load if a large unit or block of energy was unavailable. In Elfin, it was necessary to commit plants in order for them to be available for meeting spin (additional load), especially if the energy were to come from an upper block of a slow start unit. Seven percent used to be the target for commit and spin. However, staff has updated the assumption based on information obtained through the restructuring process. It is likely the California Power Pool will have a 3.5 percent (mainly combustion turbines) spin target plus 3.5 percent non-spin target. Since staff assumed a lower spin target of 3.5 percent, the commitment target was also set at 3.5 percent.

Demand Side Management (DSM)

DSM characterizations were updated to reflect new information provided by the Energy Commission's Demand Analysis Office. Staff incorporated the "Business as Usual with Spillover" case[4] of the draft ER 96 DSM numbers.

[4] Draft ER 96 Demand Side Management, May 17, 1996, Demand Analysis Office, California Energy Commission.

Additional Resources

Electricity resource additions remain the same for Edison as those used in the June 1995 report. Staff does not affirm or assume that these resources would necessarily be built, repowered or returned to service, but did incorporate them as a reasonable proxy for something that would be available in a restructured environment, regardless of the provider. When staff changed the reserve margin, LADWP's resource plan no longer required additional resources to meet load.

Emission Factors and RECLAIM

Modeling of power plants under the RECLAIM program remains the same as the June 1995 report. RECLAIM limits the amount of NOx emissions that can be produced by stationary sources within the SCAB. RECLAIM and the Federal SOx markets for pollution trading credits have been considered in this analysis by ascribing a cost penalty to production of these pollutants. The cost to dispatch such plants is based on the updated NOx RECLAIM prices from the Energy Commission Demand Analysis Office. These updated prices were incorporated into both Edison and LADWP data sets (Table 3). SOx RECLAIM prices remain the same as reported in the adopted ER94 data sets.

TABLE 3
PROJECTED RECLAIM PRICES
($/TON - Nominal Dollars)

Year	ER94	Staff Draft ER 96
1996	10,400	533
1997	12,640	6,589
1998	15,550	8,005
1999	20,230	10,018
2000	27,280	13,097
2001	30,880	15,463
2002	36,400	17,835
2003	42,050	20,833
2004	43,740	22,362
2005	45,490	23,295
2006	47,300	24,269
2007	49,200	25,258
2008	51,160	26,287
2009	53,210	27,356
2010	55,340	28,471

Source: L. Marshall, California Energy Commission, Demand Analysis Office, August 1996.

Annual South Coast Air Basin NOx Allocations for Edison and LADWP in 2010 are 1219 and 418 tons, respectively. In all scenarios, both utilities exceeded their RECLAIM allocations. Table 4 presents the South Coast Air Basin NOx emissions in tons for both utilities.

TABLE 4
SCAB GROSS POWER PLANT NOx EMISSIONS - 2010
(Tons)

Scenario	Edison	LADWP
Basecase	1437	675
84% Off-Peak Recharging, 0.24 kWh/mile EV efficiency	1474	692
84% Off-Peak Recharging, 0.35 kWh/mile EV efficiency	1502	701
95% Off-Peak Recharging, 0.24 kWh/mile EV efficiency	1495	695
95% Off-Peak Recharging, 0.35 kWh/mile EV efficiency	1530	703

Source: California Energy Commission, Electricity Resource Assessment Office, September 1996.

Under the South Coast Air Quality Management District's RECLAIM program, no South Coast Air Basin NOx emissions will result from a generation increase due to EV loads if the utility has exceeded its allocation. If the utility has reached its RECLAIM emissions allocation and additional generation necessary to charge EVs would cause the utility's gross emissions to exceed the emissions allocation, the utility must take action to reduce emissions. Potential actions include reducing emissions from its own generators by, for example, installing additional emissions controls, or by eliminating emissions from other sources through the purchase of additional RECLAIM trading credits. In this circumstance, the net emissions from utility and non-utility emission sources would be offset and no net emissions would occur.

The manner in which a utility chooses to comply with the RECLAIM program is not specified in our ER process. Gross power plant NOx emissions will increase. CARB requested that we provide gross NOx emissions information so that parties could assess both gross and net emissions, in part because the program they are considering extends statewide.

IV. RESULTS

The results presented in this section consider a basecase (no EVs) and several scenarios with different assumptions about EV market penetration and efficiencies. The scenarios being considered are the following for both Edison and LADWP:

- 84% Off-Peak Recharging Profile with 0.24 Kwh per mile EV efficiency
- 84% Off-Peak Recharging Profile with 0.35 Kwh per mile EV efficiency
- 95% Off-Peak Recharging Profile with 0.24 Kwh per mile EV efficiency
- 95% Off-Peak Recharging Profile with 0.35 Kwh per mile EV efficiency

Each of the four scenarios assume that 55 percent of EVs operating within California are located in the South Coast Air Basin.

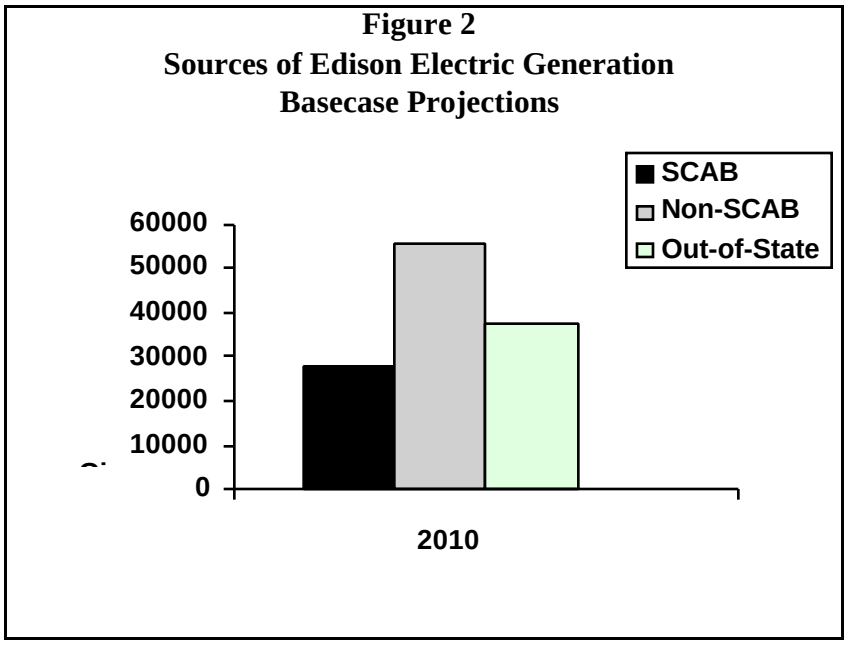
Staff used the Elfin production cost model to determine which power plants generate electricity and emissions in the Edison and LADWP service territories. Emissions are reported for NOx and ROG.

Most of the data contained in this section are presented in graphic format. Readers interested in the specific numbers should look in the Appendix of this study (Appendix Tables 1-3).

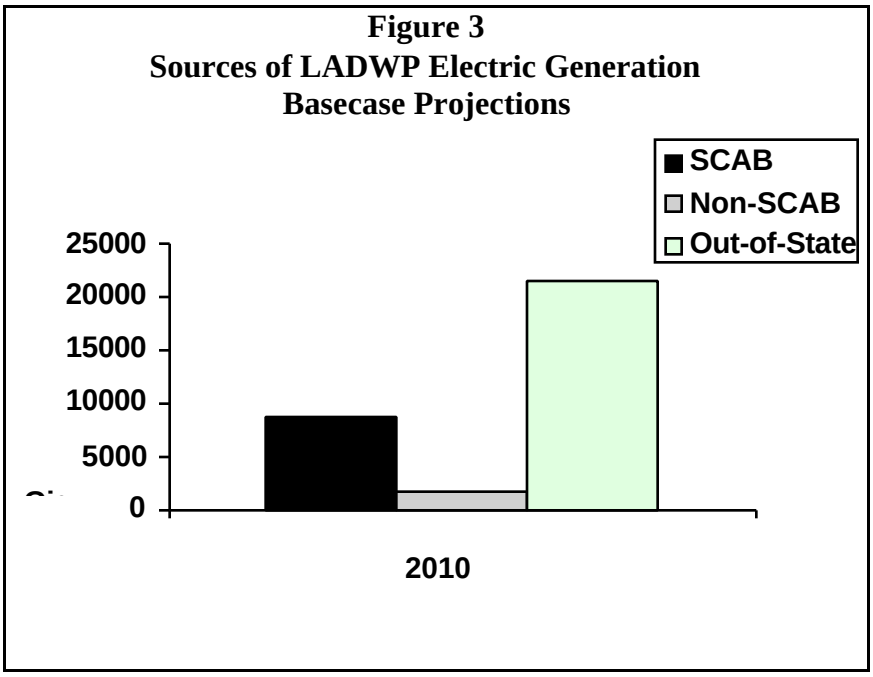
Sources of Electric Generation: Basecase and Incremental Loads

Figures 2-7 reveal some interesting insights about the resources expected to meet each utility's incremental EV demand and how they compare with baseline projections. Figure 2 indicates that most of Edison's basecase requirements are expected to come from sources outside the South Coast Air Basin. In 2010, almost one-third of the total system requirements are expected from sources outside of California. About one-quarter of the requirements will be met from facilities inside South Coast Air Basin.

Figure 2
Sources of Edison Electric Generation
Basecase Projections



For LADWP, the allocation of electric generation resources in the basecase is considerably different than results generated for Edison. As shown in Figure 3, approximately 70 percent of LADWP's basecase requirements are met by out-of-state resources, with another 25 percent coming from within the South Coast Air Basin. Because LADWP has been historically dependent on power purchases from outside California, less than five percent of total requirements are expected to be met from in-state resources outside the South Coast Air Basin. In contrast, Edison relies heavily on in-state sources outside the South Coast Air Basin to meet its electricity requirements.



In contrast to the Basecase requirements for Edison, the majority of incremental generation for EVs will come from the South Coast Air Basin (Figures 4 and 5). Fossil-fueled power plants, particularly coal-fired generation from out-of-state and natural gas resources in-basin, account for almost all EV charging. The in-basin units that provide the next increment of energy, or the marginal plants, are generally oil and gas turbines, large capacity multiple block units that can ramp-up, and follow baseload plants. Generation from facilities located in the South Coast Air Basin will satisfy more than 50 percent of Edison's EV demand in 2010. South Coast Air Basin facilities will provide about two-thirds of the electricity needed for EV recharging in the LADWP service territory in 2010 (Figures 6 and 7). Virtually all remaining generation requirements will be met by facilities outside California.

Figures 4-7 also illustrate the extent of incremental generation in the South Coast Air Basin relative to non-South Coast Air Basin facilities assuming an 84 percent non-peak generation profile. Although not shown graphically, Elfin produces nearly identical results for scenarios assuming a 95 percent non-peak generation profile.

Figure 4
Sources of Incremental Edison Electric Generation - 2010
84% Off-Peak Recharge
0.24 kWh per Mile Efficiency

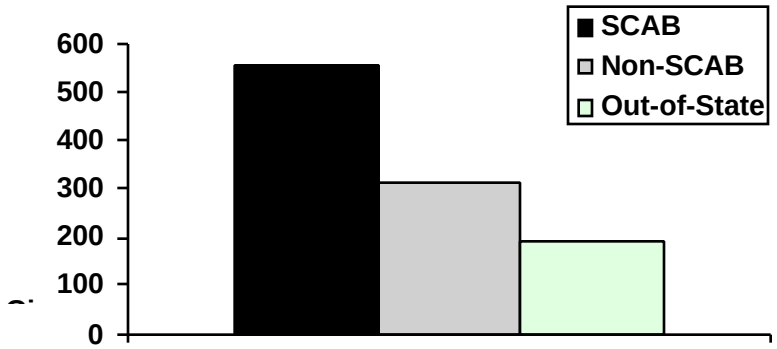


Figure 5
Sources of Incremental Edison Electric Generation - 2010
84% Off-Peak Recharge
0.35 kWh per Mile Efficiency

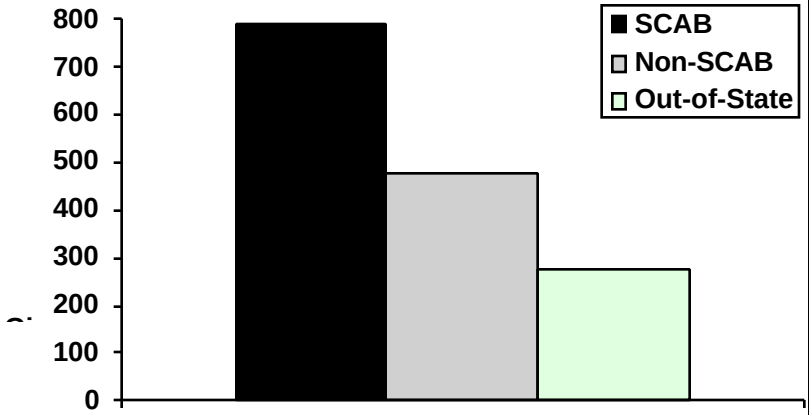


Figure 6
Sources of Incremental LADWP Electric Generation
84% Off-Peak Recharge
0.24 kWh per Mile Efficiency

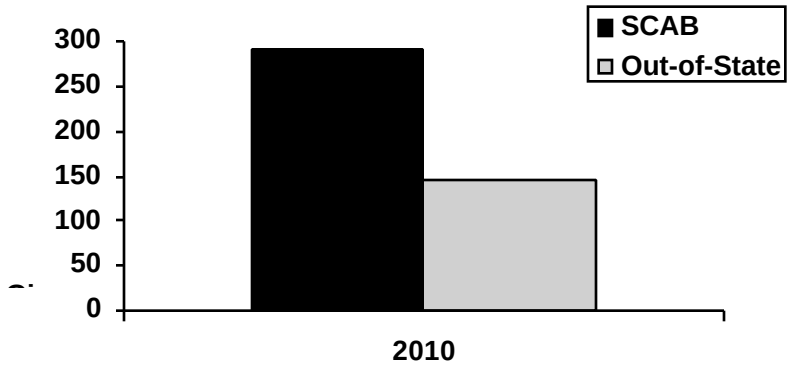
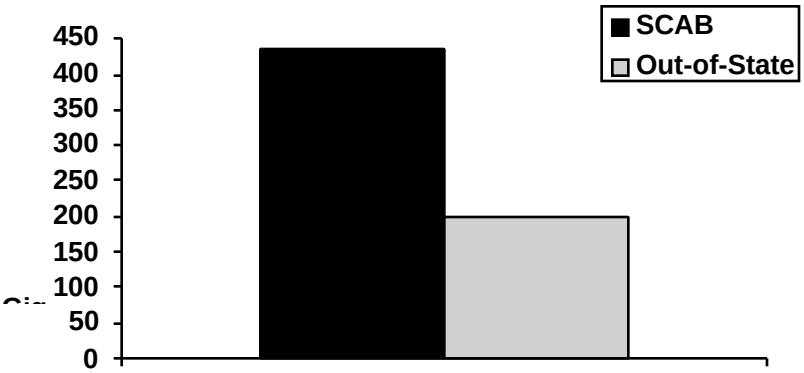
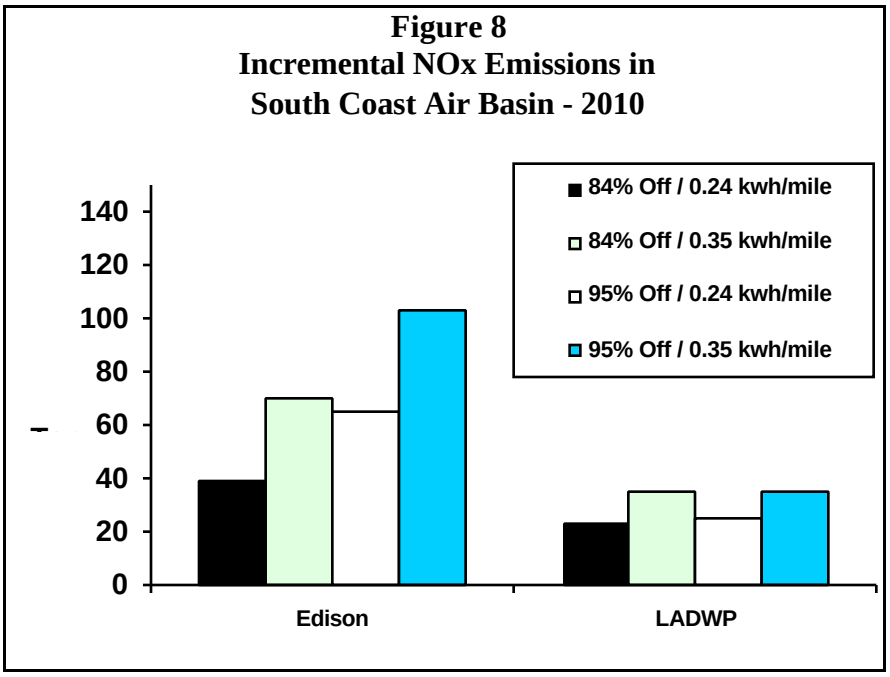


Figure 7
Sources of Incremental LADWP Electric Generation
84% Off-Peak Recharge
0.35 kWh per Mile Efficiency

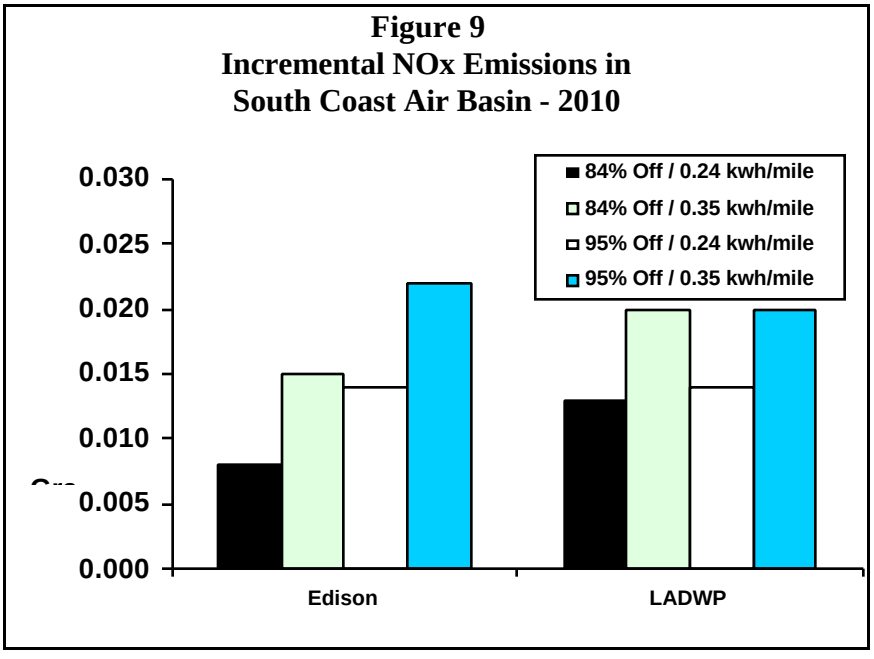


Incremental Emission Rates

Figures 8-9 present projected incremental NOx power plant emissions in the South Coast Air Basin for Edison and LADWP for each of the four scenarios. Given the greater load in the Edison service territory, most of the incremental NOx emissions in tons associated with generating electricity for EVs are greater for Edison (Figure 8).



A review of the emissions in grams per mile reveals a different picture. In 2010, LADWP per unit emissions exceed Edison's in both cases assuming 84 percent of recharging occurs during off-peak periods (Figure 9). LADWP per unit emissions are slightly less than Edison's in the 95 percent recharging scenario with 0.35 kWh per mile efficiency. Per unit emissions are about the same for the 95 percent recharging scenario with 0.24 per kWh efficiency.



Figures 10-11 present projected incremental ROG power plant emissions in the South Coast Air Basin for Edison and LADWP for each of the four scenarios. From a tonnage standpoint, Edison emits almost twice as many tons as LADWP. However, on a per unit basis, Edison's per unit emissions are virtually equal to LADWP's for the 84 percent recharging scenarios while in excess of LADWP's for the 95 percent recharging scenarios.

Figure 10
Incremental ROG Emissions in
South Coast Air Basin - 2010

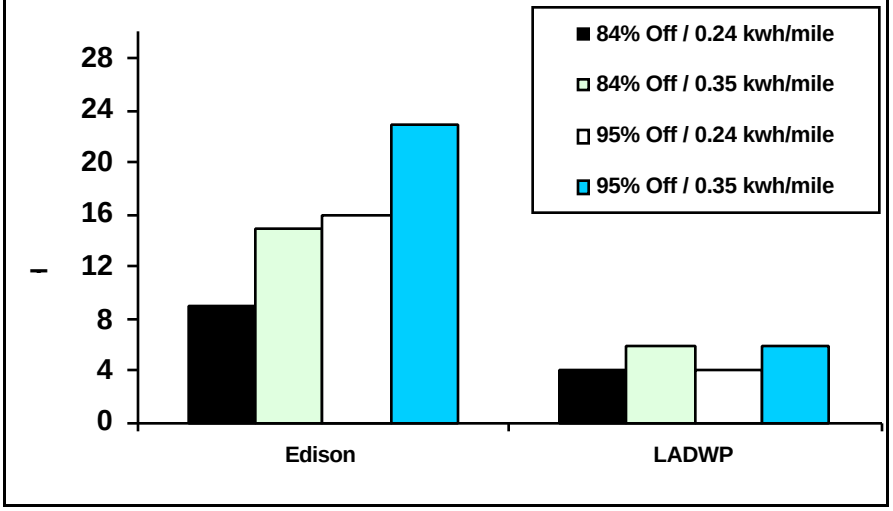
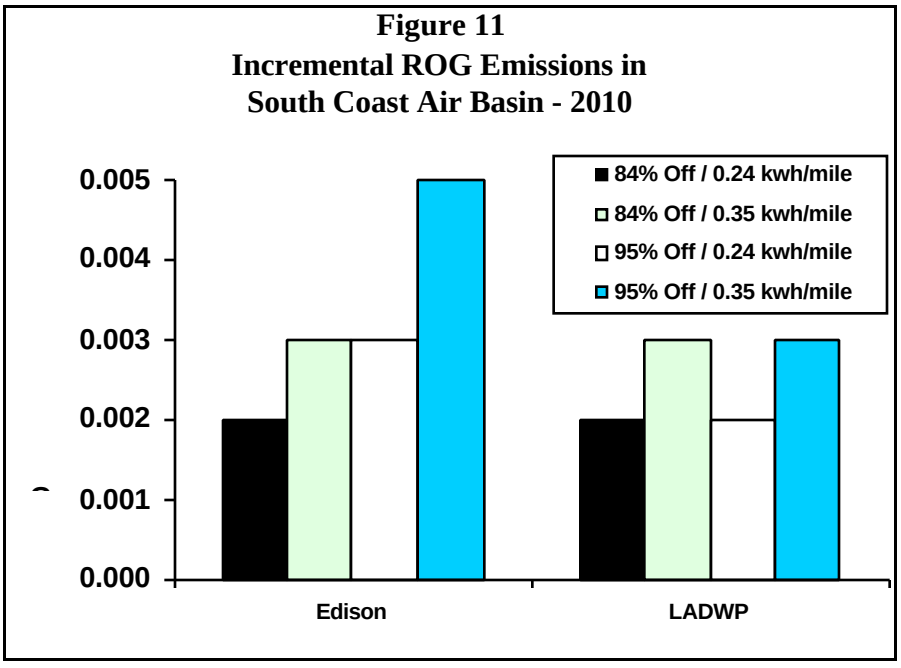


Figure 11
Incremental ROG Emissions in
South Coast Air Basin - 2010



Figures 12-13 present the projected total incremental emissions for LADWP and Edison.

Figure 12
Total Incremental NOx Emissions -All Regions
2010

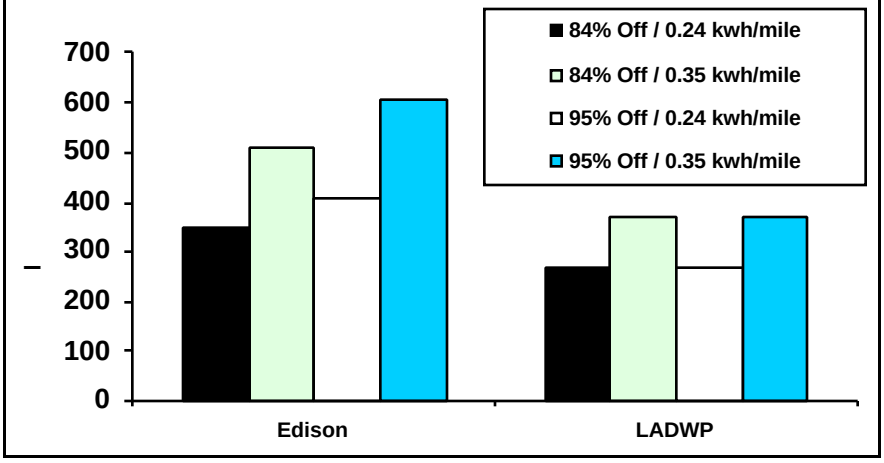
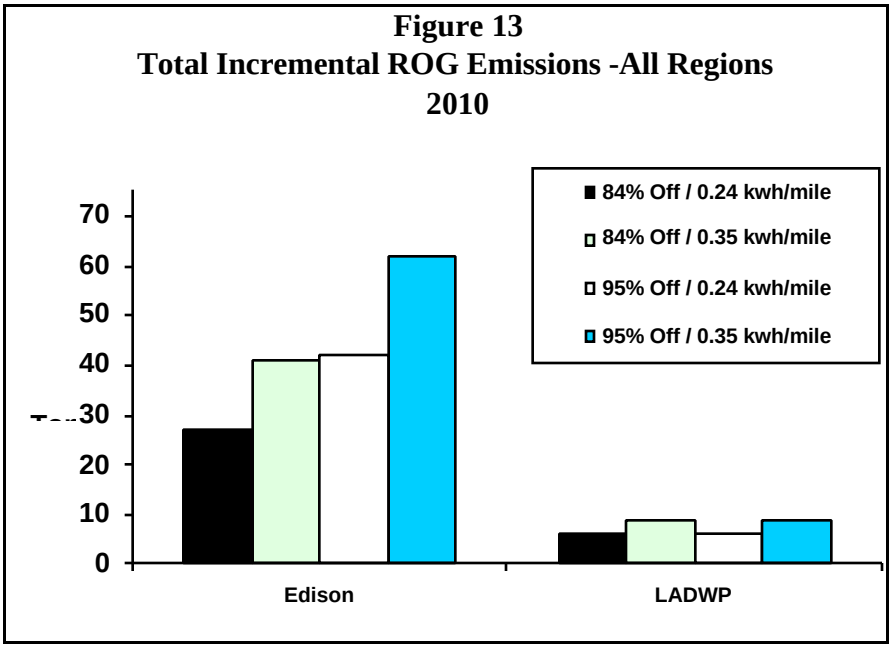


Figure 13
Total Incremental ROG Emissions -All Regions
2010



V. CONCLUSION

The results in this analysis differ little from the previous study reported in June 1995. Table 5 compares the results of this study with interim results from July 1996 and the June 1995 report. Results differ little from the June 1995 study. For Edison, 50-55 percent of the incremental generation comes from South Coast Air Basin power plants (previously 40-50 percent), and for LADWP 66-68 percent (previously 60-70 percent). Incremental gross emission rates for Edison NOx and ROG range from 0.010 to 0.022 grams per mile and 0.002 to 0.005 grams per mile respectively, (previously 0.009-0.028 and 0.001-0.005 grams per mile, respectively). LADWP's gross NOx and ROG emission rates range from 0.076 to 0.132 grams per mile and 0.002 to 0.014 grams per mile, respectively (previously 0.0106-0.177 and 0.002-0.014, respectively). Appendix Table 3 lists the South Coast Air Basin power plants modeled in the Elfin data sets.

TABLE 5
INCREMENTAL POWER PLANT EMISSIONS[5]
FROM ELECTRIC VEHICLE RECHARGING - 2010
(Grams per Mile)
Note: All cases assume 55% of EVs Operate in South Coast Air Basin

					Current Case	
Case Description	Utility	Emission Type	June 95 Case	June 96 Case	Without RECLAIM NOx Offsets	With RECLAIM NOx Offsets
84% Off-Peak Recharging Scenario	Edison	NOx	0.012	n/a	0.008	0.000
		ROG	0.002	n/a	0.002	0.002
0.24 kWh per Mile EV Efficiency	LADWP	NOx	0.013	n/a	0.013	0.000
		ROG	0.001	n/a	0.002	0.002
84% Off-Peak Recharging Scenario	Edison	NOx	0.021	0.025	0.015	0.000
		ROG	0.004	0.004	0.003	0.003
0.35 kWh per Mile EV Efficiency	LADWP	NOx	0.018	0.018	0.020	0.000
		ROG	0.002	0.002	0.003	0.003
95% Off-Peak Recharging Scenario	Edison	NOx	0.010	n/a	0.014	0.000
		ROG	0.004	n/a	0.003	0.003
0.24 kWh per Mile EV Efficiency	LADWP	NOx	0.015	n/a	0.014	0.000
		ROG	0.002	n/a	0.002	0.002
95% Off-Peak Recharging Scenario	Edison	NOx	0.013	n/a	0.022	0.000
		ROG	0.005	n/a	0.005	0.005
0.35 kWh per Mile EV Efficiency	LADWP	NOx	0.024	n/a	0.020	0.000
		ROG	0.003	n/a	0.003	0.003

Source: California Energy Commission, Electricity Resource Assessment Office, September 1996.

The results shown in the rightmost two columns of the above table show the difference between "gross" utility power plant NOx emissions and "net" emissions, taking into account utility

[5] If the utility is at its RECLAIM emissions cap and then exceeds the cap because of additional load caused by recharging EVs, the incremental emissions will be offset by whatever manner the utility chooses to return to at or below their cap. If the utility is below its RECLAIM emissions cap and exceeds the cap because of additional load caused by recharging EVs, then the amount over the cap will be offset but the amount below the cap will not. This analysis indicates that combined Edison and LADWP incremental emissions for NOx due to EV recharging will range from 0-138 tons (zero to 0.022 grams per mile). See Appendix Tables 1 and 2.

actions to reduce the amount of emissions exceeding its RECLAIM allocation. As stated earlier, potential actions could include installing additional emissions controls, or by eliminating emissions from other sources through the purchase of additional RECLAIM trading credits. In this circumstance, the net emissions from utility and non-utility emission sources would be offset and no net emissions would occur.

Staff believes this study is the best approximation at this time of incremental power plant emissions in the South Coast Air Basin associated with EV loads. Staff has used the best available modeling tools and assumptions to provide this information to CARB for their proceeding. This comports with how the future restructured electricity market could operate over the next decade or more and affect power plant emissions.

APPENDIX

APPENDIX TABLE 1[6]
INCREMENTAL POWER PLANT EMISSIONS
IN EDISON SERVICE TERRITORY DUE TO ELECTRIC VEHICLES

Note: All cases assume 55% of EVs Operate in South Coast Air Basin

			2010		2010	
Case	Case Description	Emission Type	Incremental Tons	Grams per Mile	RECLAIM Tons Offset	Grams per Mile
1	84% Off-Peak Recharging Scenario	NOx	39	0.008	-39	0.000
	0.24 kWh per Mile EV Efficiency	ROG	9	0.002	n/a	0.002
2	84% Off-Peak Recharging Scenario	NOx	70	0.015	-70	0.000
	0.35 kWh per Mile EV Efficiency	ROG	15	0.003	n/a	0.003
3	95% Off-Peak Recharging Scenario	NOx	65	0.014	-65	0.000
	0.24 kWh per Mile EV Efficiency	ROG	16	0.003	n/a	0.003
4	95% Off-Peak Recharging Scenario	NOx	103	0.022	-103	0.000
	0.35 kWh per Mile EV Efficiency	ROG	23	0.005	n/a	0.005

Source: California Energy Commission, Electricity Resource Assessment Office, September 1996.

APPENDIX TABLE 2[7]
INCREMENTAL POWER PLANT EMISSIONS
IN LADWP SERVICE TERRITORY DUE TO ELECTRIC VEHICLES

Note: All cases assume 55% of EVs Operate in South Coast Air Basin

			2010		2010	
Case	Case Description	Emission Type	Incremental Tons	Grams per Mile	RECLAIM Tons Offset	Grams per Mile
5	84% Off-Peak Recharging Scenario	NOx	23	0.013	-23	0.000
	0.24 kWh per Mile EV Efficiency	ROG	4	0.002	n/a	0.002
6	84% Off-Peak Recharging Scenario	NOx	35	0.020	-35	0.000
	0.35 kWh per Mile EV Efficiency	ROG	6	0.003	n/a	0.003
7	95% Off-Peak Recharging Scenario	NOx	25	0.014	-25	0.000
	0.24 kWh per Mile EV Efficiency	ROG	4	0.002	n/a	0.002
8	95% Off-Peak Recharging Scenario	NOx	35	0.020	-35	0.000
	0.35 kWh per Mile EV Efficiency	ROG	6	0.003	n/a	0.003

Source: California Energy Commission, Electricity Resource Assessment Office, September 1996.

APPENDIX TABLE 3
GENERATION UNITS INCLUDED IN SOUTH COAST AIR BASIN

Southern California Edison

[6] Gross" utility power plant NOx emissions refer to actual emissions produced by a generating facility. If the utility exceeds its RECLAIM allocation, the utility must take action to reduce emissions. Potential actions could include installing additional emissions controls, or by eliminating emissions from other sources through the purchase of additional RECLAIM trading credits. In this circumstance, the "net" emissions from utility and non-utility emission sources would be offset and no net emissions would occur.

[7] Ibid.

Steam Turbine Alamitos #1-6 El Segundo #1-4 Etiwanda #1-4 Highgrove #1-4 Huntington #1-4 Redondo Beach #5-8 San Bernardino #1-2 Combined Cycle Long Beach #8-9 Combined Cycle - Existing Combustion Turbines Alamitos #7 Anaheim Gas Turbine Etiwanda #5 Huntington #5 Vernon Diesel #1-5 Vernon Gas Turbines #1-2	Qualifying Facilities AES Placerita Carson Energy Inc. Harbor Cogeneration LA Sanitation Dist (Puente Hills) Midway-Sunset Cogeneration Sunlaw Cogen Sycamore Cogeneration ARCO Watson Cogeneration Exports Edison to SMUD

Los Angeles Department of Water and Power

Steam Turbine Harbor #3-5 (Repower) Haynes #1-6 Scattergood #1-3 Valley #1-4 Combustion Turbines Harbor #6-9	Self Generation Hydro Cogeneration Biomass Contracts West Branch - LA Dept of Water Resources